Hot Ground Vibration Tests

Completed Technology Project (2014 - 2015)

Project Introduction

Ground vibration tests or modal surveys are routinely conducted to support flutter analysis for subsonic and supersonic vehicles. However, vibration testing techniques for hypersonic vehicles are not as well established due to the thermoelastic interactions that can occur when high-temperature materials are incorporated into a hot structure that contains metallic components. The thermoelastic interaction between those materials can affect the hypersonic flutter analysis. In recent years, numerous high-temperature materials, new fabrication technologies, and sensors have been explored for hypersonic vehicle applications. This research team is working to develop a high-temperature modal survey to expand the research database for hypersonics and improve the understanding of such dual-material interactions.

Work to date: NASA Armstrong directed a program to test a Carbon-Silicon Carbide (C/SiC) Ruddervator Subcomponent Test Article (RSTA) to support hypersonic material research. The RSTA has undergone numerous thermal, thermal-mechanical, and thermal-vibration tests. This research team conducted three modal surveys involving the RSTA to characterize the thermoelastic interaction of the hot-structure control surface. The team obtained good modal data at lower temperatures, but the off-the-shelf, high-temperature accelerometers malfunctioned on the hotter region of the test article. The experiments yielded test data that will be useful for future work and launched a high-temperature accelerometer development effort.

Looking ahead: The research team has obtained custom-made and multiple other high-temperature accelerometers and are taking steps to understand, evaluate and characterize their complexity and functionality in preparation for future thermoelastic vibration tests.

Benefits

- **Innovative**: Expands the research database for hypersonics through high-temperature modal testing
- **Pioneering**: Extends the understanding of the modal characteristics effects from high temperatures on hypersonic vehicle materials
- **Aids research**: Contributes to the understanding of flutter behavior at high temperatures
- **Reduces risk**: Will aid in the future design of hypersonic vehicles

Applications

- Hypersonic vehicle research and design

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

Responsible Program:

Center Innovation Fund: AFRC CIF

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Anticipated Benefits

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- **Pioneering**: Extends the understanding of the modal characteristics effects from high temperatures on hypersonic vehicle materials
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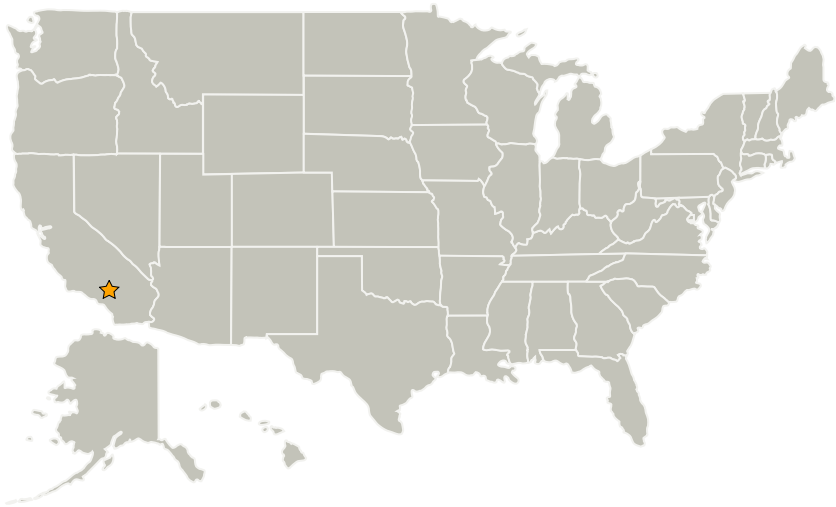
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Armstrong Flight Research Center(AFRC)	Lead Organization	NASA Center	Edwards, California

Project Management

Program Director:
Michael R Lapointe

Program Manager:
David F Voracek

Principal Investigator:
Natalie D Spivey

Co-Investigator:
Larry D Hudson

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.3 Thermal Protection Components and Systems
    - TX14.3.3 Thermal Protection Analysis